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Original communication

Macroscopically detected female genital injury after consensual and non-consensual vaginal penetration: A prospective comparison study

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ABSTRACT

Objective: The aim of this study was to compare the prevalence, type and pattern of macroscopically detected female genital injury after consensual and non-consensual vaginal penetration to further an understanding of the forensic significance of genital injury in women reporting sexual assault. A secondary aim was to identify any effect of a range of possible variables upon the likelihood of genital injury resulting from vaginal penetrative sexual intercourse.
Study design: Two groups of reproductive age women (aged 18–45 years) were prospectively recruited within 72 h of a single episode of vaginal penetrative sex, and macroscopically examined for the presence of bruises, abrasions and lacerations at twelve external and internal genital sites. Forty one women who presented for forensic examination after reporting a sexual assault to police were recruited to the non-consensual group and 81 women who presented for routine cervical screening or with sexual health concerns to a primary health care service to the consensual group. Each group was examined by a different group of doctors, all of whom were experienced in both forensic genital examination and gynaecological examination of healthy and diseased sexually active women. Data collection and examination protocols were the same for both groups.
Results: The key finding was a statistically significant difference in genital injury prevalence between women who were vaginally penetrated non-consensually and consensually; 53.7% of the non-consensual group (22/41) and 9.9% of the consensual group (8/81) were found to have at least one genital injury [OR 10.57, CI (4.07, 27.42), $p < 0.00001$]. Penetration with finger/s and possible pre-existing genital 'infection' were found to be significantly associated with the presence of injury in the univariate analysis after adjusting for consent. Logistic regression demonstrated that women penetrated without consent were 19.5 times more likely to sustain at least one genital injury, than those penetrated consensually [OR 19.53, CI (6.03, 63.24)] and that a penetration scenario that included finger/s was 4.2 times more likely to result in at least one genital injury than penetration without finger involvement [OR 4.25, CI (1.42, 12.78)], when controlling for other variables in the model. Whilst a comparatively low injury prevalence in the consensual group limited interpretation, results revealed possible differences in genital injury typology and pattern resulting from non-consensual and consensual vaginal penetration. Lacerations were seen after both consensual and non-consensual vaginal penetration, while abrasions and bruises were seen exclusively in the non-consensual group.
Conclusion: This study demonstrated a significant consent group difference in genital injury prevalence and the highest macroscopically detected genital injury prevalence rate resulting from non-consensual vaginal penetration identified to date. Results also indicate that vaginal penetration with finger/s increases the likelihood of sex-related injury. The difference in type of injury sustained as a result of non-consensual and consensual vaginal penetration was an unexpected finding, and warrants further

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investigation. These results highlight the importance of a standardised means of detecting genital injury based on consistent injury definitions, examination protocols, and examiner experience and suggest that macroscopic genital examination may be uniquely placed to detect consent group differences in injury typology and pattern if they exist.

1. Introduction

Despite the frequent focus of sexual assault trials upon the issue of consent, the vast majority of female genital injury research to date has concentrated exclusively on injury arising non-consensually, and is therefore of little value in the interpretation of its significance in relation to consent. To date, considerable effort has been exerted investigating genital injury in sexual assault complainants using a range of different genital examination methods. Most of this research has been done by retrospective record review with outcomes which are difficult to interpret because of methodological inconsistencies. The relative paucity of robust genital injury studies in consensually sexually active women is a serious omission from the literature.

While most genital injury research is confined to the forensic field, useful information can be derived from other 'non-forensic' sources. Studies of genital injury after consensual sex can be found in sexual health and reproductive medicine, investigating the relationship of injury to risk of sexually transmitted infection[1,2] or the use of various contraceptive measures.[3–6] Although the interpretive value of these studies may be limited to some degree by the lack of a forensic approach to the genital examination, they cannot be ignored given the need for comparative data about genital injury resulting from consensual sex.

In Australia, adult sexual assault complainants are forensically examined without magnification or genital staining; clinicians routinely perform 'naked eye' or macroscopic genital examinations to detect injury. For this reason, the results of non-consensual genital injury studies using colposcopy and/or staining methods have little relevance for medical witnesses tasked with interpreting genital examination findings for the courts in this country. However, because macroscopic genital examination is the routine method for examining healthy, consensually sexually active women in the primary health care setting, it is the only genital examination method with a readily available means of collecting comparative data in relation to genital injury resulting from consensual sex. As such, macroscopic genital examination studies have the greatest potential to assist the courts with respect to the issue of genital injury and consent.

A total of 85 papers citing female genital injury prevalence data were identified by systematic *PubMed* and *National Library of Medicine (US)* searches; study methodology and outcomes were reviewed and key features summarised to assess interpretive value. Seventy papers considered injury due to non-consensual sex, 8 injury due to consensual sex and 7 compared injury in non-consensual and consensual groups. The primary aim of nine of the 70 non-consensual sex studies was to explore the relationship between genital injury and legal outcome. Two important papers which did not provide genital injury prevalence data were considered separately; one explored changes in patterns of genital injury resulting from consensual sex over time[7] and the other, a consent group comparison study, investigated the possibility of a predictive model for genital injury and consent.[8]

1.1. Genital injury studies of greater interpretive value

To assist interpretation, papers were first categorised by genital examination protocol used. Many studies lacked clarity about the methods by which injuries were detected and the order in which they were performed if more than one examination method was used. Because detection of genital abrasions and lacerations is enhanced by toluidine blue staining while bruise detection is reduced,[9] the timing of genital stain application is important and has the potential to affect injury detection rates. Colposcopic studies did not always specify the magnification used and two studies used colposcopic equipment during genital examination solely for 'photo-documentation' of macroscopically detected injury.[10,11] Five different genital examination protocols were identified as follows;

i. Macroscopic.
ii. Staining and macroscopic.
iii. Colposcopic.
iv. Staining and colposcopic.
v. Combination of macroscopic, colposcopic and staining.

The following methodological criteria were then used to select 46 key studies considered to be of greater interpretive value;

i. Prospective design.
ii. Penetration to examination time (PET) of less than 72 h.
iii. Exclusion of prepubertal and postmenopausal subjects.
iv. Exclusion of non-specific examination findings 'redness' and 'swelling'.
v. Exclusion of anal penetration scenario and anal/perianal examination findings.

No study met all five criteria; however all met at least one and most at least two. Table 1 summarises this information for 39 key studies providing non-consensual genital injury prevalence data by method of examination[10–48] and Table 2 does the same for 14 key studies citing consensual genital injury prevalence data.[1,3,4,9,23,25–27,34,39,44,49–51] Seven consent group comparison studies cited both consensual and non-consensual genital injury rates[23,25–27,34,39,44] and therefore appear in both tables.

1.2. Genital injury prevalence data

Table 3 summarises the ranges of genital injury prevalence data found as a result of non-consensual and consensual sex, for each of the five identified examination protocols in the 46 'key' studies. Significant variation in injury prevalence can be seen between studies, even when using the same genital examination protocols. Injury prevalence ranges appear similar in both consent groups using most examination protocols, with the possible exception of the staining/macroscopic examination studies. This may relate to the use of differing study methodology for consent groups in the majority of these studies. Only 7 studies investigated both consent groups simultaneously; however, not all applied the same methodology to both consent groups.[23,44]

Table 4 lists features of the seven consent group comparison studies citing injury prevalence data published to date. Of the body of work addressing this subject, it is these studies which provide the most valuable contribution to the debate about the significance of sex-related genital injury in relation to consent.

Table 1
Key studies citing non-consensual sexual intercourse (NCSI) genital injury prevalence data.

Method of examination	Author	Year	Design	Excludes redness/ swelling	Excludes anal/ perianal	Excludes prepubertal/ postmenopausal	Penetration to examination time (PET)	Age of subjects	Sample size (NCSI)	Genital injury prevalence
Macroscopic only	Tintinalli[12,k]	1985	Retrospective	No	Yes	No	95% <24 h	13–78 yrs	372	18%
	Cartwright[13]	1986	Retrospective	Yes	No	No	Not stated	≥10 yrs	440	28%
	Cartwright[14]	1987	Retrospective	Yes	No	No	Not stated	≥10 yrs	161	21%
	Manser[15]	1991	Retrospective	No[a]	Yes	No	64% <24 h	12–69 yrs	103	37%
	Rambow[16,k]	1992	Retrospective	Yes	Yes	No	<36 h	>16 yrs	182	9%
	Ramin[17]	1992	Retrospective	No	Yes	Probably	56% <6 h	14–49 yrs	129	18%
	Bowyer[18]	1997	Retrospective	Yes	No	Yes	'Most' <24 h	16–48 yrs	83	27%
	Wiley[10,k]	2003	Retrospective	Yes	No	No	74% <24 h	>15 yrs	365	18%
	Palmer[19]	2004	Retrospective	Yes	No	No	<72 h	14–73 yrs	153	22%
	Sugar[11]	2004	Retrospective	Yes	No	No	77% <24 h	15–87 yrs	759	20%
	Hilden[20]	2005	Retrospective	Yes	No	Yes	<72 h	20–49 yrs	143	27%
	Crane[21]	2006	Retrospective	Yes	No	No	85% <72 h	13–87 yrs	620	20.5%
	White[22]	2006	Retrospective	Yes	Yes	No[b]	Not stated	12–17 yrs	224	40%
	McLean[23,j]	2011	Retrospective (NCSI only)	Yes	Yes	No[c]	<48 h	≥18 yrs	500	22.8%
	Morgan[24]	2011	Retrospective	Yes	No	Separate groups	81% <48 h 86% <48 h	18–47 yrs Postmenopausal	130 122	17% 37%
Staining/macroscopic	Lauber[25,j]	1982	Prospective	Yes	Yes	No	<48 h	Not stated	22	40%
	McCauley[26,j]	1986	Prospective	Yes	Yes	No	<48 h	11–18 yrs	25	Macro 4% Stain 28%
	McCauley[27,j]	1987	Prospective	Yes	Yes	Probably	<48 h	19–55 yrs	24	Macro 4% Stain 58%
Colposcopy	Baker[28]	2008	Retrospective	No	No	Yes	<72 h	22–29 yrs	94	58.5%
	Maguire[29]	2009	Retrospective	Yes	No	No	85% <72 h	13–74 yrs	153	39%
	Texeira[30]	1981	Prospective	No	Hymen only	No	Not stated	4–51 yrs 91% < 18yrs	500	11.9% increase in detection colpo *vs* macro.
	O'Brien[31]	1997	Retrospective	No	No	No	<72 h	≥18 yrs	Macro 56 Colpo 60	Macro 36% Colpo 60%
	Lenahan[32]	1998	Prospective	Yes	No	No	<24 h	>15 yrs	17	Macro 6% Colpo 53%
Staining/colposcopic	Slaughter[33]	1992	Retrospective	No	Yes	No	<48 h	13–85 yrs	131	87%
	Slaughter[34,j]	1997	Retrospective	No	No	No	<24 h	11–85 yrs	142	89%
	Lindsay[35,k]	1998	Retrospective	No[d]	No	No	<72 h	12–95 yrs	642	73%
	Adams[36]	2001	Retrospective	No	No	Probably	87% <72 h	14–19 yrs	214	72%
	Sachs[37]	2002	Retrospective	Yes	No	Yes	87% <24 h	Not given[e]	209	80%
	Jones[38]	2003a	Retrospective	No	No	No	<72 h	13–17 yrs 18–84 yrs	329 437	83% 64%
	Jones[39,j]	2003b	Retrospective	No	No	No	90% <72 h	13–17 yrs	204	85%
	Jones[40]	2003c	Prospective	Yes	Yes	Yes	85% <72 h	13–19 yrs[f]	20	15% labial traction 60% balloon
	Jones[41]	2004a	Prospective	Yes[g]	Yes	No	89% <72 h	12–45 yrs	27	67%
	Jones[42]	2004b	Retrospective	No	No	No	Not stated	13–82 yrs	849	71–77%
	Sommers[43]	2006	Retrospective	Yes	Yes	Probably	<72 h	14–39 yrs	40	52.5%
	Anderson[44,j]	2006	Retrospective	Yes[h]	Yes	No	<24 h	16–54 yrs	56	32.1%
	Stears[45]	2008	Retrospective	No	No	Yes[i]	Not stated	12–18 yrs	1024	77%
	Drocton[46]	2008	Retrospective	Yes	No	No	75% <72 h	12–92 yrs	3356	49.9%
	Jones[47]	2009b	Retrospective	No	No	Yes	<72 h	19–39 yrs	1610	62.9%
Macroscopic, staining and colposcopy	Rogers[48]	2008	Prospective	No	No	No	84% <48 h	13–74 yrs	445	68% all 3 methods combined

[a] Includes tenderness and redness, but not swelling.
[b] 93.3% post-menarchal, 2.7% pre-menarchal, 4% menarchal status not recorded.
[c] When postmenopausal excluded from analysis, results 'didn't change substantially'.
[d] Includes redness and swelling only if 'localised'.
[e] All were menstruating regularly.
[f] All were at Tanner Stage III of pubertal development.
[g] Abrasions and lacerations only.
[h] Used TEARS but excluded redness and swelling.
[i] All pubertal.
[j] Consensual and non-consensual sexual intercourse genital injury comparison study.
[k] Legal outcome study.

1.3. Consent group comparison studies

1.3.1. Staining/macroscopic consent group comparison

Although the need for comparative genital injury data after non-consensual and consensual sex was recognised by researchers investigating the use of genital staining techniques in detecting injury as early as the 1980s,[25–27] these relatively small studies utilising toluidine blue, were never progressed with larger sample sizes. They did, however, provide the first evidence of a difference in genital injury prevalence after consensual and non-consensual sex.

Lauber's study with 22 participants in each consent group found 40% non-consensual *vs* 4.5% consensual with injury,[25] and McCauley's 1987 study with 24 in the non-consensual group and 48 in the consensual group identified 58% non-consensual *vs* 10% consensual with injury.[27] Both studies were prospective in design

Table 2
Key studies citing consensual sexual intercourse (CSI) genital injury prevalence data.

Method of examination	Author	Year	Design	Excludes redness/ swelling	Excludes anal/ perianal	Excludes prepubertal/ postmenop.	Penetration to examination time (PET)	Age of subjects	Sample size (CSI)	Genital injury rate
Macroscopic only	McLean[23,e]	2011	Prospective (CSI only)	Yes	Yes	No[a]	<48 h	≥18 yrs	68	5.9%
Macroscopic and staining	Lauber[25,e]	1982	Prospective	Yes	Yes	No	<48 h	Not stated	22	4.5%
	McCauley[26,e]	1986	Prospective	Yes	Yes	No	<48 h	11–18 yrs	25	Macro 0% Stain 28%
	McCauley[27,e]	1987	Prospective	Yes	Yes	Yes	<48 h	19–43 yrs	48	Macro 0% Stain 10%
Colposcopy	Soper[4]	1991	Prospective	Yes	Yes	Yes	<24 h	≥18 yrs	30	0%
	Fraser[1]	1999	Prospective	No	Yes	Yes	<24 h	18–35 yrs	103	25.2%
	Eschenbach[3]	2001	Prospective	No	Yes	Yes	8–12 h	18–40 yrs	42	Vulva 27% Vagina 5%
Colposcopic and staining	Norvell[49]	1984	Prospective	No	Yes	Yes	6 h post CSI	23–35 yrs	18 (6 h)	61.1%
	Slaughter[34,e]	1997	Retrospective	No	Yes	No	<24 h	13–48 yrs	75	11%
	Jones[39,e]	2003b	Retrospective	No	No	No	90% <72 h	13–17 yrs	51	73%
	Anderson[44,e]	2006	Prospective	Yes[b]	Yes	Yes	<24 h	21–45 yrs	46	30.4%
Macroscopic, staining and colposcopy	Sommers[50]	2008	Prospective	No	No	No	<24 h	≥21 yrs	120	55% all 3 methods combined
	Zink[9,c]	2010	Prospective	No[d]	No	No	<24 h	21–68 yrs	120	55% all 3 methods combined
	Astrup[51]	2012	Prospective	Yes	Yes	Yes	<48 h	19–40 yrs	98	Macro 34% Colpo 49% Stain/colpo 52%

[a] When postmenopausal excluded and results 'didn't change substantially' so not excluded.
[b] Used TEARS but excluded redness and swelling.
[c] Appears to be same study group as Sommers (2008).
[d] Used TEARS but excluded swelling.
[e] Consensual and non-consensual sexual intercourse genital injury comparison study.

with consensual group women recruited from emergency department or outpatient clinics at the time of presentation, if they reported consensual sex within the previous 48 h. While participant age and penetration scenario was unclear in Lauber's study, McCauley's participants were aged 19–55 yrs and were all penetrated vaginally. Both studies examined the external genitalia only.

McCauley published a similar study in paediatric and adolescent subjects the previous year.[26] Her adolescent participants were recruited prospectively in the same way with 25 in each consent group; age range was 11–18 years and all were examined within 48 h of vaginal penetration. Of note is that genital injury was macroscopically detected after staining in 28% of each consent group; that is, despite finding significantly different consent group injury prevalence rates in her adult study, there was no difference in injury prevalence between her adolescent consent groups.

1.3.2. Staining/colposcopic consent group comparison

Later, those pioneering the use of colposcopy in the forensic examination of sexual assault complainants attempted to compare genital injury rates in different consent groups,[34,39] but recruited their consensual subjects from those presenting to sexual assault services. Slaughter's[34] consensual group comprised 75 subjects who had initially presented to a sexual assault service alleging recent non-consensual sex, but who later withdrew their allegations and said that sexual intercourse had been consensual rather than non-consensual. Jones's 2003 study[39] recruited 51 adolescents to a consensual group from those brought to a sexual assault service by their parents for statutory reasons after sex which the adolescents themselves viewed as consensual. The uncertainty as to consent associated with this means of recruitment to a consensual group is problematic and compromises interpretation. Both studies examined subjects colposcopically after genital staining with toluidine blue; Slaughter's study population were aged 11–85 years and Jones's 13–17 years. Slaughter found genital injury in 89% of non-consensual and 11% of consensual subjects. As was the case with the adolescent staining/macroscopic consent group comparison study described earlier,[26] Jones identified similar rates of genital injury in his adolescent non-consensual and consensual groups; 85% non-consensual *vs* 73% consensual subjects with injury.

More recently, Anderson[44] compared genital injury detected colposcopically after toluidine blue staining in 46 consensual subjects recruited prospectively by advertisement, with data from retrospective record review of 56 non-consensual cases. Women aged 16–54 years were examined within 24 h of sexual intercourse, presumed to be penile vaginal penetration although not specifically stated; six external and internal sites were examined for bruises, abrasions and lacerations. She found little difference in genital injury prevalence between consent groups; 32.1% non-consensual *vs* 30.4% consensual subjects with injury.

Table 3
Ranges of genital injury prevalence cited in 46 'key' studies.

Method of examination	Consensual SI	Non-consensual SI
Macroscopic	0–34%	4–40%
Staining/macroscopic	4.5–28%	28–58%
Colposcopic	0–49%	39–60%
Staining/colposcopic	11–73%	15–89%
Combination all 3 methods	55%	68%

SI = sexual intercourse.

1.3.3. Macroscopic consent group comparison

Fortuitously for those jurisdictions where staining or colposcopic examination is not used routinely for sexual assault forensic examinations, the most recently published consent group comparison study[23] has been done using only macroscopic genital examination. McLean's study, like Anderson's,[44] looked at genital injury in a prospectively recruited consensual group and compared findings with data from retrospectively reviewed sexual assault complainant records. Prospective consensual group recruitment was achieved by flyer sent out with a Pap smear reminder letter.

Table 4
Genital injury consent group comparison studies.

Author	Year	Method of examination	PET	Sample size		Non-consensual GI rate	Consensual GI rate	Features
				NCSI	CSI			
Lauber[25]	1982	Stain/macroscopic	<48 h	22	22	40%	4.5%	Prospective NCSI and CSI
McCauley[26]	1986	Stain/macroscopic	<48 h	25	25	28%	28%	Prospective NCSI and CSI Adolescents only
McCauley[27]	1987	Stain/macroscopic	<48 h	24	48	58%	10%	Prospective NCSI and CSI
Slaughter[34]	1997	Stain/colposcopic	<24 h	311	75	89%	11%	Retrospective NCSI and CSI[a] Includes adolescents and postmenopausal Includes redness and swelling
Jones[39]	2003b	Stain/colposcopic	90% <72 h	204	51	85%	73%	Retrospective NCSI and CSI[a] Adolescents only Includes redness, swelling and anal findings
Anderson[44]	2006	Stain/colposcopic	<24 h	56	46	32.1%	30.4%	Prospective CSI Retrospective NCSI
McLean[23]	2011	Macroscopic	<48 h	500	68	22.8%	5.9%	Prospective CSI Retrospective NCSI Includes postmenopausal

PET = penetration to examination time.
NCSI = non-consensual sexual intercourse.
CSI = consensual sexual intercourse.
[a] Consent status uncertainty.

Participants in this study were aged 18 years and over, with no upper age limit specified; 8% of 500 non-consensual subjects and 28% of 68 consensual subjects were aged over 45 years. Examination for bruises, abrasions and lacerations at five external and internal genital sites within 48 h of penile vaginal penetration revealed 22.8% of non-consensual cases and 5.9% of consensual cases with injury.

1.4. Genital injury pattern data

For some researchers, the lack of a difference between consent group injury prevalence appears to have been the catalyst for a closer look at genital injury typology and patterns, in an effort to distinguish between injuries seen as a result of consensual and non-consensual sex. Three consent group comparison studies using examination enhancement techniques, identified little difference in genital injury prevalence rate between groups[26,39,44]; however, two of these focused exclusively on adolescent populations.[26,39]

Whilst not the first to consider the concept of a 'consent group specific' genital injury pattern,[33,52–54] Anderson's study of reproductive age women which identified similar consent group injury prevalence rates, was the first to attempt a predictive model for 'consent' based on genital injury pattern using a logistic regression model. She claimed that 85% of non-consensual cases and 90% of consensual cases could be correctly identified by considering 'total surface area of injury' and 'number of sites with tears, bruises, abrasions and redness', while controlling for time from penetration to examination.[8] Furthermore, 'total injury surface area' and 'number of sites with redness and bruises' were found to be 'individually predictive' for consent. Her efforts were, however, hampered by small sample sizes with only 40 subjects in each consent group, and by the inclusion of colposcopically-detected 'redness' as a positive injury finding. This non-specific genital finding was seen more frequently and at a greater number of sites in the consensual than the non-consensual group. Her inclusion of 'total surface area of injury' as an injury pattern variable also compromised results by failing to acknowledge the variation in morphology of bruises, abrasions and lacerations.

To date, researchers have employed a broad range of variables when referring to the concept of 'genital injury pattern'; injury type, genital site,[33,34] injury severity,[19,55–59] number of injuries, number of sites injured, number of sites with a given type of injury, and injury size or total surface area of injury.[7,8] Anderson's attempt at a predictive model for consent using injury pattern variables, although not without problems, is a valuable contribution to research in the area, not only for proposing a statistical means of approaching the question of consent, but also because it clearly identifies the problem with defining 'redness' as injury in the genital area. It is, however, clear that larger, more methodologically robust studies are needed to determine whether such a model might be achievable in the future.

1.5. Methodological issues

Whilst a considerable body of work exists in relation to sex-related female genital injury, methodological variation has rendered much of it of little interpretive value. The inclusion of redness and swelling, anal findings, adolescent or postmenopausal subjects, different penetration scenarios and long penetration to examination times distort research outcomes and contribute to inconsistencies in injury prevalence results. Failure to exclude more than one recent episode of sexual penetration, and any other recent penetrative acts that may have resulted in injury, such as the insertion of tampons,[1,60–67] intra-vaginal contraception,[1,68] or even a speculum[1,27,41] may affect study outcomes. Lack of information about factors with the potential to affect whether injury will occur or not, such as skin pigmentation,[43,69–72] use of condoms and/or lubricant,[3,4] use of hormonal preparations, previous vaginal deliveries or genital surgery, and genital infection or inflammation at the time of penetration, is less than ideal.

More recently, genital injury studies have sought to address some of these issues by using prospective study design, standardised pathological injury definitions, clearly defined examination protocols, and acknowledging that genital tissue is subject to hormonal effects on genital tissue by considering adolescent and postmenopausal women separately, significantly improving the ability to interpret study findings.

The considerable challenges involved in recruiting subjects for examination after consensual sex, have led to a number of creative approaches in this respect. Uncertainty about consent status with

early studies using sexual assault complainants who 'withdrew' allegations[34] prompted researchers to seek volunteers to attend for genital examination after an episode of consensual sex, solely for the purpose of the study[51] or when they attended for a routine Pap smear.[23] It is possible that consensual sex that is, in effect 'premeditated' or carried out with the knowledge of subsequent participation in research, may differ from spontaneous sex and as such, may alter outcomes. Ideally, consent group comparison studies should prospectively recruit women to both groups at the time of presentation for genital examination, following the index episode of sexual intercourse rather than prior to it.

1.6. Rationale for this study

The legal implications of research outcomes in this area demand a robust methodological approach. To address the need for reliable comparative information about female genital injury resulting from consensual and non-consensual vaginal penetration, and ensure relevance to Australian jurisdictions, this study was therefore designed to incorporate the following elements;-

i. Prospectivity and recruitment of all participants at the time of presentation for genital examination.
ii. All examining clinicians experienced in examination of normal, healthy and diseased female genitalia as well as forensic sexual assault examinations.
iii. All participants of reproductive age without heavily pigmented skin.
iv. The same information about a range of possible confounding variables sought from participants at the time of examination.
v. All genital examinations performed within 72 h of a single episode of vaginal penetrative sex, consensual or non-consensual in nature.
vi. The same macroscopic examination protocol used for all participants

2. Method

2.1. Aims

The specific aim of this study was to compare the prevalence, type, and pattern of genital injury found in two cohorts of reproductive age women; a 'consensual group' presenting for genital examination in a primary care setting who had had recent consensual vaginal penetrative sex and a 'non-consensual group' attending for a forensic examination after reporting recent sexual assault involving vaginal penetration to the police. A secondary aim was to identify any effect of a range of possible confounding variables upon the prevalence, type and pattern of genital injury seen.

2.2. Sample size considerations

Based on the lower limit of estimated macroscopically-detected genital injury prevalence for each consent group available at the time of study initiation, that is, 2% in the consensual group and 20% in the non-consensual group, a calculation of the sample size required to detect a difference in injury prevalence of 18% indicated that 57 participants were required for each group.[73,74] In order to carry out secondary analyses to identify injury patterns and factors associated with genital injury, sample sizes of 100 participants in each group were aimed for, but study time limits meant it was only possible to recruit 81 participants to the consensual group and 41 participants to the non-consensual group.

2.3. Participants and recruitment

Participants were women aged 18–45 years, attending a general practice, women's health care centre or sexual assault service who were capable of understanding the contents of the study *Information Sheet* and *Consent Form* at the time of the examination. Sex-workers and women with heavily pigmented skin were excluded. Recruitment was conducted between January 2004–September 2010; each doctor recruited for a continuous period of time, varying in length from 10 months to 5.5 years.

Inclusion criteria were identical for each consent group, the only difference being whether the index 'episode' of vaginal penetration was identified by the woman as consensual or non-consensual. Women were approached at the time of presentation for forensic or gynaecological examination. No woman was approached if there was not a clinical, screening or forensic indication for a complete genital examination that included speculum examination of the vagina and cervix, based on her reason for presentation.

All participants were specifically questioned about all episodes of vaginal penetrative sex within the 72 h prior to examination. Those reporting more than one episode of vaginal penetrative sex within the previous 72 h, whether consensual or non-consensual, were excluded from the study. Thus, a woman considered for the non-consensual group was not included if she had also had an episode of consensual vaginal penetrative sex in the previous 72 h, or if she had been sexually assaulted vaginally on two separate and distinct occasions within the previous 72 h. Similarly, a woman considered for the consensual group was not included if she had had more than one episode of consensual vaginal penetrative sex or had also been sexually assaulted vaginally in the previous 72 h. The possibility of unreported recent non-consensual vaginal penetrative sex in a woman considered for the consensual group, could not be eliminated with complete certainty; however the context of presentation for a gynaecological examination, in addition to discussion of the study with the examining doctor, increased the likelihood of disclosure. Recruiting doctors were instructed to respond to any such disclosure as they would do without involvement in the study; that is, to offer referral to police and/or sexual assault service for forensic medical examination and counselling support.

2.3.1. Consensual group recruitment

Eighty one participants were recruited to the consensual group by three general practitioners at the time of presentation to one of four primary health care services: an inner city teaching general practice, a multidisciplinary women's health service and a rural women's health clinic in Western Australia, and a suburban general practice on the Gold Coast in Queensland. Consensual group doctors recruited over a continuous period of time which varied in length from 10 to 18 months. All patients attending for genital examination for any reason were considered for the study and consecutively recorded by code on a data record sheet; discussion about the study took place prior to genital examination and the patient's inclusion or reason for non-inclusion was noted. Approximately 16% of patients attending for genital examination were recruited to the study; of those not included, 48% were outside the required age range and 52% had not had sex within the previous 72 h.

2.3.2. Non-consensual group recruitment

Forty one participants were recruited to the non-consensual group at the time of presenting to one of three public teaching hospitals in South East Queensland, for forensic sexual assault examination by one of four forensic medical officers employed by the Clinical Forensic Medicine Unit; all had reported a sexual assault to

police. Each non-consensual group doctor recruited over a continuous period of time ranging in length from 6 months to 5.5 years. All women attending for forensic examination were considered for the study and were consecutively recorded by code on a data record sheet; the woman's inclusion or reason for non-inclusion was noted. Discussion about the study took place after the genital examination to avoid increasing anxiety about the examination. If there was any question of whether vaginal penetration had occurred or not, the woman was not recruited to the study, unless she described genital symptoms reliably consistent with recent sex and/or had sustained genital injuries suggestive of recent vaginal penetration. If a woman subsequently told police that she had fabricated the allegation, she was excluded from the study. Of 147 sexual assault complainants seen over the study period by the four examining doctors, 28% were recruited to the non-consensual group; of those not included, 40% were outside the required age range or had heavily pigmented skin, 24% had had an episode of consensual sex within previous 72 h, 8% had no memory of or symptoms suggestive of penetration, and 8% were not competent to consent to participation. The remainder either declined study involvement, admitted allegations were false or were considered too distressed to approach.

2.4. Examining clinicians

All examiners were doctors with forensic and primary care gynaecology experience. A separate group of doctors examined each consent group; that is, no doctor examined both consensual and non-consensual group cases. Each of the three consensual group doctors had worked in general practice and women's health for at least 10 years and had participated for at least 5 years in a 24 h roster to provide forensic sexual assault examinations. Each of the four non-consensual group doctors had at least 5 years experience in general practice, women's health or sexual health medicine and had participated in a 24 h roster to provide forensic sexual assault examinations for at least 2 years. All doctors had been trained forensically to use the same standardised injury definitions and examination protocols by the lead author.

2.5. Genital examination protocol

The external genitalia, vaginal canal and cervix of all participants were examined macroscopically; that is, by direct visualisation without magnification, genital staining or photography, using disposable transparent plastic specula with either an in-built fibreoptic speculum light or a flexible gynaecological examination light. Patients were examined in modified lithotomy position; that is, lying supine with hips partially abducted, knees flexed and feet placed on the examination bed or foot rests.

2.5.1. Genital sites examined

Twelve genital sites were examined in each woman: *mons, outer labia majora, inner labia majora, labia minora,* clitoris/clitoral hood, peri-urethral area, fossa navicularis, posterior fourchette, hymen, vaginal walls, cervix, perineum. Genital sites with bilateral components were identified as a single site of injury if injuries occurred on both sides.

2.5.2. Injury definitions

Three injury types were recorded:

i. *Bruises* defined as localised areas of discolouration (grey, blue, purple, red, green, yellow, brown or mixed) without disruption of skin or mucosa.
ii. *Abrasions* defined as areas of superficial skin or mucosal disruption with or without associated bleeding, which may be linear/one-dimensional or non-linear/two-dimensional.
iii. *Lacerations* defined as superficial or deep 'splits' or 'tears' in the skin or mucosa with or without associated bleeding, with edges that could be re-opposed without surface deficit.

Size, shape, site and specific features of injuries were recorded according to WAQID,[75] a genital injury database developed specifically for the purpose of this research. Injury dimensions were measured to nearest 0.5 cm based on known dimension of a swab head or fingernail. Any clinical evidence of infection or inflammation was recorded and testing was performed at time of examination, as appropriate.

2.6. Data recording

A six page data record form which included detailed external genitalia and internal genital tract diagrams, was used for all participants. Examination findings were drawn directly onto genital diagrams at the time of examination. All data record forms were de-identified and allocated a code by the examining doctor.

2.7. Data analysis

All data forms were checked and information entered onto WAQID. Data was then exported into the PASW GradPack 18 software system (www.spss.com) for analysis. Pearson χ^2 or Fisher's exact tests was used to determine differences between groups of categorical variables and odds ratios (OR) with 95% confidence intervals (CI) calculated to identify any significant differences between consent groups and any associations with the presence of genital injury at univariate level. Comparative analysis of a number of consent subgroups was also undertaken. Where there were no events for a given outcome in (only) one of the groups, 0.5 was added to facilitate probabilistic sensitivity analysis in line with statistical convention.[76,77] Logistic regression was then performed using variables that were significant in the univariate analysis after adjusting for consent to penetration to fit the model, and calculation of Wald χ^2 test statistic.[73,74,78,79]

2.8. Ethical considerations

This research was conducted as the basis for a Doctor of Philosophy thesis[101] at the University of Western Australia (UWA) and as such, was approved by the *UWA Human Research Ethics Committee (HREC),* which is bound by the *National Health and Medical Research Council (NHMRC) Ethics Guidelines.* In addition, approval for the study was granted by each hospital and primary health care service at which examinations were conducted. Written consent was given by each participant after reading and discussing a detailed *Information Sheet* with the examining doctor. All data records were de-identified and stored securely.

3. Results

3.1. Description of consent groups

3.1.1. Participant characteristics

A total of 122 participants were recruited to the study; 81 to the consensual group and 41 to the non-consensual group. Comparison of consent groups is summarised in Table 5.

Mean age for the non-consensual group was slightly younger (27.51 yrs) than that of the consensual group (31.05 yrs). Three age categories within the specified participant age range of 18–45 years

Table 5
Comparison of consent group participants.

	Non-consensual group ($n = 41$)		Consensual group ($n = 81$)		OR (95% CI)	p-Value
	n	%	n	%		
Penetration to examination time (PET)						
PET <24 h	37	*90.2*	23	*28.4*	23.33 (7.47–72.87)	<0.005*
PET <48 h	41	*100*	58	*71.6*	33.34 (1.97–564.6)	0.02*
Penetration history						
Penis only	19	*46.3*	47	*58*	0.62 (0.29–1.33)	0.22
Finger/s only	8	*19.5*	0	*0*	42.11 (2.36–750.99)	0.01*
Penis and finger/s	9	*22*	30	*37*	0.48 (0.20–1.14)	0.09
Penetration by >1 type of article	10	*24.4*	34	*42*	0.45 (0.19–1.03)	0.06
Penetration included a penis	29	*70.7*	81	*100*	0.01 (0.00–0.25)	0.00
Penetration included finger/s	18	*43.9*	32	*39.5*	1.20 (0.56–2.56)	0.64
Penetration included an object	1	*2.4*	4	*4.9*	0.48 (0.05–4.45)	0.52
No use of condom or lubricant	38	*92.7*	58	*71.6*	5.02 (1.41–17.90)	0.01*
Use of tampon <72 h	5	*2.4*	1	*1.2*	11.11 (1.25–98.57)	0.03*
Speculum examination <72 h	1	*2.4*	0	*0*	6.11 (0.24–153.52)	0.27
No prior vaginal penetrative sex	1	*2.4*	1	*1.2*	2.00 (0.12–32.81)	0.63
Participant characteristics						
Age category						
18–21 yrs	14	*34.1*	13	*16*	2.71 (1.13–6.52)	0.03*
22–29 yrs	13	*31.7*	27	*33.3*	0.93 (0.42–2.07)	0.86
30–45 yrs	14	*31.7*	41	*50.6*	0.51 (0.23–1.10)	0.09
Non-pigmented skin type	37	*90.2*	65	*80.2*	2.28 (0.71–7.32)	0.17
Pregnant or breastfeeding	2	*4.9*	2	*2.5*	2.03 (0.27–14.93)	0.49
Any hormonal contraception	12	*29.3*	40	*49.4*	0.42 (0.19–0.95)	0.04*
History of obstetric injury or surgery						
Vaginal deliveries	16	*39*	34	*42*	0.88 (0.41–1.91)	0.75
Episiotomy	5	*12.2*	15	*18.5*	0.61 (0.21–1.82)	0.38
Obstetric vaginal tears	1	*2.4*	6	*7.4*	0.31 (0.04–2.69)	0.29
Genital 'infection' at examination						
Symptoms at examination	16	*39*	13	*16*	3.35 (1.41–7.94)	0.01*
Symptoms onset pre-penetration	1	*2.4*	9	*11.1*	0.20 (0.02–1.64)	0.13
Laboratory evidence of infection	11	*26.8*	8	*9.9*	3.35 (1.22–9.14)	0.02*
Symptom onset pre-penetration + laboratory evidence of infection	0	*0*	4	*6.2*	0.21 (0.01–4.00)	0.30

*Statistical significance $p < 0.05$.

were considered; 18–21 years, 22–29 years and 30–45 years; there were similar proportions of women aged 22–29 years and 30–45 years in each consent group, however more women in the non-consensual group fell into the 18–21 year age group. No participants had a coagulopathy or connective tissue disease and none were taking anticoagulants, steroids or topical genital preparations at the time of the study. One woman gave a history of genital dermatitis, but had no symptoms or signs at time of examination. No women were post-partum, postmenopausal or on hormone replacement; however three were in their first trimester of pregnancy and one was breastfeeding. Consent groups did not differ significantly in participant history of vaginal deliveries or previous obstetric injury or episiotomy. However, more consensual group than non-consensual group women were taking some form of hormonal contraception at the time of penetration and examination [OR 0.42, CI (0.19, 0.95), $p = 0.01$].

3.1.2. Timing of examination

All participants were examined within 72 h of a single episode of vaginal penetration. Non-consensual group participants were examined sooner within this time frame than consensual group participants; all of the non-consensual group and 72% of the consensual group were examined within 48 h of penetration.

3.1.3. Vaginal penetration history

All participants reported penetration vaginally by penis, finger/s or object or various combinations of these. The most frequent index penetration scenario was penetration with penis only or with penis and finger/s; 105 or 86% of all participants had experienced one of these penetration scenarios. There was no statistical difference between consent groups in penetration that involved finger/s or an object. An object was used in the index penetration of one woman in the non-consensual group and four women in the consensual group; in all cases object penetration was in combination with penis and/or fingers. Penetration exclusively by finger/s occurred in eight women, all of whom were penetrated non-consensually.

Consent groups differed significantly in numbers of women penetrated without use of a condom or lubricant [OR 5.02, CI (1.41, 17.90), $p = 0.01$] and numbers of women who had inserted a tampon within the 72 h prior to examination [OR 11.11, CI (1.25, 98.57), $p = 0.03$]. A condom and/or lubricant was used more often during consensual (23/81, 28%) than non-consensual index penetration (3/41, 7%). Within the 72 h period prior to examination, five women in the non-consensual group and one in the consensual group had inserted a tampon, and one woman in the non-consensual group had undergone a speculum examination. For one woman in each group, the index penetration was her first ever sexual vaginal penetration.

3.2. Genital injury prevalence

Genital injury was found to be significantly more likely in the non-consensual group than in the consensual group [OR 10.57, CI (4.07, 27.42), $p < 0.00001$]; 53.7% (22/41) of women penetrated non-consensually were found to have at least one genital injury compared to 9.9% (8/81) of those penetrated consensually.

When only those women examined within 48 h of penetration were considered ($n = 90$), this difference remained statistically significant with 56% (19/34) of non-consensual group compared to 12% (6/56) of consensual group found to have genital injury [OR

10.56, CI (3.57, 31.21), $p < 0.005$]. Similar statistically significant differences in injury prevalence between consent groups were identified when only women examined within 48 h of penetration with a penis, or with penis and finger/s were considered ($n = 75$); 50% (11/22) of non-consensual group had at least one injury compared to 11% (6/53) of consensual group [OR 7.83, CI (2.38, 25.80), $p < 0.005$]. When all cases using a condom and/or lubricant were excluded ($n = 59$), injury prevalence in the two consent groups remained significantly different; 50% (10/20) of non-consensual cases and 13% (5/39) of consensual cases had at least one genital injury [OR 6.80, CI (1.88, 24.56), $p < 0.005$].

3.3. Factors influencing the likelihood of injury

In univariate analysis, genital injury was statistically more likely to be seen in women examined within 24 h of penetration [OR 4.88, CI (1.90, 12.54), $p < 0.005$], if penetrated with finger/s only [OR 11.25, CI (2.13, 59.31), $p < 0.005$] and if a woman had laboratory evidence of genital infection at the time of examination [OR 3.51, CI (1.27, 9.75), $p = 0.02$]. Penetrative episodes involving a penis were less likely to result in genital injury than penetrative episodes that didn't [OR 0.19, CI (0.05, 0.65), $p = 0.01$]. Age within the study range, use of a condom and/or lubricant, or the insertion of a tampon in 72 h preceding examination did not significantly alter the likelihood of injury.

Three variables were found to be significantly associated with the presence of injury after adjusting for consent to penetration; the involvement of finger/s in the penetrative episode, the presence of genital symptoms prior to penetration and the combination of both genital symptoms present prior to penetration and laboratory evidence of 'infection' at examination. Logistic regression was performed using all predictors for the model as shown in Table 6, and found to be statistically significant [χ^2 40.73 (5, $n = 122$), $p < 0.001$], indicating that the model improved the prediction of likelihood of genital injury. The model as a whole explained between 28.4% (*Cox and Snell* R^2) and 42.2% (*Nagelkerke* R^2) of the variance in injury status, and correctly classified 84.4% of cases. Only the involvement of finger/s in the penetrative episode and non-consent made a unique statistically significant contribution to the model; the strongest predictor of injury was non-consent, with an OR of 19.529 indicating that women who were penetrated non-consensually were 19.5 times more likely to sustain an injury, than those penetrated consensually, controlling for other factors in the model. The OR for the inclusion of fingers in the penetrative episode was 4.252, indicating that a penetrative episode that included finger/s was 4.2 times more likely to result in an injury that penetration without finger involvement.

3.3.1. Penetration with finger/s

Whilst genital injury rates were the same for consensual group women penetrated exclusively with a penis (10%, 5/48) and penetrated with penis and finger/s (10%, 3/30), the inclusion of finger/s in a non-consensual penetrative episode increased the rate of injury; 37% (7/19) sustained injury when penetrated exclusively with a penis while 78% (7/9) did so when penetrated with penis and finger/s.

Eight women in the study were penetrated exclusively with finger/s, all non-consensually and none involving the use of lubricant. Six of these eight women were found to have genital injury. Penetration exclusively with finger/s was more likely than any other penetration scenario to result in an injury [OR 11.25, CI (2.13, 59.31), $p < 0.005$].

3.3.2. Genital 'infection'

Genital 'infection' at the time of penetration was a reasonable presumption in four women who had genital symptoms of onset prior to penetration, and laboratory evidence of an alteration in genital flora (referred to as 'infection') at examination. All four women were in the consensual group and two sustained injury. Despite the small numbers involved, this is a higher injury rate (50%, 2/4) than that identified for the whole consensual group (9.9%, 8/81).

3.3.3. Condom and/or lubricant use

Condom and/or lubricant use with penetration was hypothesised as having the potential to facilitate penetration and thus, reduce the likelihood of injury. While no significant relationship between the presence of injury and the use of condom and/or lubricant was identified by univariate analysis, when women penetrated exclusively with a penis were considered, injury was only seen when penetration occurred without use of a condom and/or lubricant.

3.3.4. Previous genital obstetric injury or surgery

Genital injury was not found to be significantly associated with a previous history of vaginal delivery, or obstetric genital injury or surgery. Lower genital injury rates were, however, seen in women with a history of previous vaginal delivery (20%, 10/50) than without (28%, 20/72), with a history of obstetric vaginal tears (14%, 1/7) than without (25%, 29/115) and with a history of episiotomy (20%, 4/20) than without (25%, 26/102).

3.3.5. Skin pigment

Although women with heavily pigmented skin were excluded from this study, 16% of all cases were described as having some degree of skin pigmentation, described as 'brown' or 'olive' skin. Although not statistically significant, more women with no visible

Table 6
Logistic regression model predicting likelihood of genital injury.

	β	S.E.	Wald	df	p Value	OR	95% C.I.	
							Lower	Upper
Fingers included (1)	1.447	.561	6.646	1	.010	4.252	1.415	12.779
Genital symptoms present prior to penetration (2)	1.952	1.109	3.096	1	.078	7.039	.801	61.888
Genital symptoms present prior to penetration and laboratory evidence of infection at examination (3)	1.530	1.431	1.144	1	.285	4.619	.280	76.283
Non-consent (4)	2.972	.599	24.577	1	.000	19.529	6.031	63.237
Constant	−3.482	.624	31.114	1	.000	.031		

Note: four explanatory variables significant at the univariate level were included in the final model.
β: coefficient β = the mathematical weighting of each variable in the model.
S.E.: standard error = the estimated error of the mathematical weighting.
Wald: the Wald test statistic calculated from the data to be compared with the χ^2 distribution with 1 degree of freedom.
df: degree of freedom.
p Value: the probability value indicating that variables (1) and (4) make a statistically significant contribution to the model.
OR: odds ratio controlling for other variables in the model.
95% C.I.: the 95% confidence interval for the estimated odds ratio.

injury (17%, 16/92) were identified as having pigmented skin than women with visible injury (13%, 4/30).

3.4. Genital injury typology and pattern

3.4.1. Injury type

In this study, the only type of genital injury seen in women in the consensual group was a laceration. In contrast, all three types of injuries, that is, lacerations, abrasions and bruises, were seen in non-consensual group women. A total of 84 individual injuries were detected overall; 74 in the non-consensual group and 10 in the consensual group. Lacerations were the most common injury seen overall, accounting for all consensual group injuries and 58% (43/74) of non-consensual group injuries. Abrasions and bruises were only seen in non-consensual group women and comprised 24% (18/74) and 18% (13/74) respectively of all non-consensual group injuries. Table 7 summarises consent group differences in genital injury prevalence and type.

3.4.2. Injury site

The fossa navicularis was the most common genital site for an injury to be seen overall. In the consensual group, injuries were seen at only four sites; posterior fourchette, fossa navicularis, perineum and peri-urethral area. In the non-consensual group, injuries were seen at ten sites with the fossa navicularis and labia minora most frequently injured. Table 8 compares genital injury sites in consent groups. Whilst injuries to the fossa navicularis and posterior fourchette were seen in both consent groups, these sites were statistically more likely to sustain injury in non-consensual group women. An injury to the labia minora was statistically more likely in the non-consensual group than the consensual group [OR 47.65, CI (2.69, 842.68), $p = 0.01$].

When only those women penetrated exclusively with a penis were considered ($n = 66$), the fossa navicularis remained the most frequently injured site in both groups, though statistically more likely in the non-consensual than consensual group [OR 10.38, CI (1.87, 57.72), $p = 0.01$]. In women penetrated exclusively with a penis, injuries to the inner labia majora, hymen and cervix were not seen in either group suggesting injury to these sites may relate to the involvement of finger/s.

Lacerations were seen at eight different genital sites, with approximately a third (32%, 17/53) found in the fossa navicularis. The labia minora was the next most frequent site for a laceration (23%, 12/53) followed by the posterior fourchette (19%, 10/53). The greatest proportion of abrasions was seen on the inner aspect of the labia majora (44%, 8/18) and the greatest proportion of bruises on the labia minora (31%, 4/13).

3.4.3. Injury size

Genital lacerations were, by definition, one dimensional since they were defined for the purposes of this study, as having 'edges that could be re-opposed without surface deficit'. Linear abrasions and bruises were also recorded as one dimensional. In all, 66 injuries were described as one-dimensional and 18 as two dimensional with a measurable surface area. Since lacerations were the only injury seen in the consensual group, no consensual group injuries had a measurable surface area.

Injuries were larger in the non-consensual group with more injuries having at least one dimension measuring >1 cm. The longest injury (laceration) seen in the consensual group was 1.5 cm while non-consensual group injuries measured up to 3 cm in length and 2.5 cm^2 in surface area.

Both the longest one dimensional injury and the largest two dimensional injury were seen in women penetrated non-consensually with finger/s only and examined within 12 h of penetration. One woman sustained a linear abrasion of 2.5–3 cm in length on the inner labium major and the other, an abrasion of 2.1–2.5 cm in length on the cervix.

3.4.4. Genital injury pattern

When more than one injury was seen in an individual, the term 'injury pattern' was used to describe such features as total number of injuries, injury types, genital sites injured and genital sites with more than one injury. Table 9 shows the number of injuries seen in an individual in each consent group and Table 10 summarises consent group comparison of injury pattern.

Women penetrated non-consensually were more likely than those penetrated consensually to have more than one injury [OR 22.79, CI (4.88, 106.36), $p < 0.005$] and to have multiple injuries at a single genital site [OR 16.34, CI (3.45, 77.49), $p < 0.005$]. No woman penetrated consensually had more than one type of injury, or was injured at more than one genital site.

The labia minora was the most likely site for multiple injuries resulting non-consensually whilst the posterior fourchette was the only site at which more than one injury was seen in the consensual group. Women in the non-consensual group were more likely to have more than one laceration than those in the consensual group [OR 11.11, CI (2.27, 54.28), $p < 0.005$].

When only those women examined within 48 h of penetration with a penis or penis with finger/s were considered, it was found that those in the non-consensual group remained statistically more likely than those in the consensual group to have more than one injury [OR 29.71, CI (3.42, 257.92), $p < 0.005$], to be injured at more than one site [OR 27.0, CI (1.38, 527.05), $p = 0.03$], and to have more than one injury at a single genital site [OR 19.5, CI (2.18, 174.23), $p = 0.01$]. In this sub-sample, non-consensual penetration remained more likely than consensual penetration to result in a laceration [OR 4.48, CI (1.33, 15.09), $p = 0.02$] or a bruise [OR 27.0, CI (1.38, 527.05), $p = 0.03$], but not an abrasion.

3.4.5. Consent group comparison of lacerations

Lacerations were the only injury type to arise both consensually and non-consensually and as such, the only injury type for which direct comparison between consent groups was possible. Table 11 summarises the features of lacerations seen in consensual and non-consensual groups. Lacerations seen in the non-consensual

Table 7
Consent group comparison injury prevalence and type.

	Non-consensual group ($n = 41$)		Consensual group ($n = 81$)		OR (95% CI)	p-Value
	n	%	n	%		
At least one genital injury	22	*53.7*	8	*9.9*	10.57 (4.07–27.42)	<0.00001*
Type of injury						
At least one abrasion	8	*19.5*	0	0	42.11 (2.36–750.99)	0.01*
At least one bruise	10	*24.4*	0	0	55.43 (3.15–975.14)	0.01*
At least one laceration	13	*31.7*	8	*9.9*	4.24 (1.59–11.32)	<0.005*

*Statistical significance $p < 0.05$.

Table 8
Consent group comparison of genital injury sites (all cases, $n = 122$).

At least one injury at this site	Non-consensual group ($n = 41$)		Consensual group ($n = 81$)		OR (95% CI)	p-Value
	n	*%*	*n*	*%*		
Mons	No injuries at this site in either group					
Outer labia majora	No injuries at this site in either group					
Inner labia majora	3	*7.3*	0	*0*	15.03 (0.76–298.36)	0.08
Labia minora	9	*22*	0	*0*	48.56 (2.74–859.42)	0.01*
Fossa navicularis	9	*22*	3	*3.7*	7.31 (1.86–28.77)	<0.005*
Posterior fourchette	6	*14.6*	3	*3.7*	4.46 (1.05–18.85)	0.04*
Hymen	4	*9.8*	0	*0*	19.85 (1.04–378.43)	0.05
Vaginal wall	2	*4.9*	0	*0*	10.45 (0.49–223.11)	0.13
Cervix	2	*4.9*	0	*0*	10.45 (0.49–223.11)	0.13
Peri-urethra	3	*7.3*	1	*1.2*	6.32 (0.64–62.74)	0.12
Clitoris/clitoral hood	1	*2.4*	0	*0*	6.11 (0.24–153.52)	0.27
Perineum	1	*2.4*	1	*1.2*	2.00 (0.12–32.81)	0.63

*Statistical significance $p < 0.05$.

group were longer with lengths up to 2.5 cm compared with up to 1.5 cm in the consensual group. Non-consensual group lacerations were found at a greater number of genital sites, and were most commonly seen in the fossa navicularis, whilst consensual group lacerations were most commonly seen at the posterior fourchette. Those arising non-consensually were more often multiple than single, with up to eight lacerations seen in a single individual. When more than one laceration was seen in a woman penetrated non-consensually, they were more likely to be found at different sites. More than one laceration was seen in only two women penetrated consensually; in both women, two lacerations were seen at the posterior fourchette.

3.5. Factors influencing the typology and pattern of injury

Table 12 summarises injury types seen in different penetration scenarios in consensual and non-consensual groups.

3.5.1. Penile penetration

Only 34 injuries were identified in women penetrated exclusively with a penis; 28 in the non-consensual group and 6 in the consensual group. In these women, lacerations were the only injury type seen in the consensual group (6/6, 100%) and the most common injury type in the non-consensual group (22/28, 78%), followed by bruises (4/28, 14%) and abrasions (2/28, 7%).

3.5.2. Penetration with finger/s

Lacerations were statistically less likely than other injuries if penetration involved finger/s [OR 0.21, CI (0.08, 0.55), $p < 0.005$], or if a woman was penetrated exclusively with finger/s [OR 0.05, CI (0.01, 0.26), $p < 0.005$]. Abrasions were more likely than other injury types to result from a penetration scenario involving a finger or fingers [OR 3.76, CI (1.20, 11.77), $p = 0.02$] or if penetrated only with finger/s [OR 10.0, CI (2.87, 34.84), $p < 0.005$].

Table 9
Total number of genital injuries per individual in each consent group.

No of injuries in an individual	Non-consensual group ($n = 41$)		Consensual group ($n = 81$)	
	n	*%*	*n*	*%*
None	19	*46.3*	73	*90.1*
1 injury	7	*17.1*	6	*7.4*
2 injuries	2	*4.9*	2	*2.5*
3–6 injuries	11	*26.8*	0	*0*
7–10 injuries	2	*4.9*	0	*0*
Total	**41**	***100***	**81**	***100***

Table 13 summarises the details of findings in the eight women exclusively penetrated with finger/s. All three injury types were seen in these women; however abrasions and bruises were statistically more frequent than lacerations [OR 0.05, CI (0.01, 0.26), $p < 0.005$]. Fifty per cent of all abrasions (9/18) seen in this study, were the result of finger/s only penetration. Abrasions arising as a result of finger/s only penetration were seen at genital sites which in this study, were 'unusual' sites of injury; eight of the nine abrasions seen in finger/s only penetration cases occurred on the inner labia majora and one on the cervix.

In women exclusively penetrated with finger/s, injury to the inner labia majora was significantly more likely [OR 38.29, CI (6.76, 216.85), $p < 0.005$]. Only ten injuries to the inner labia majora were seen in this study overall; eight were abrasions in women reporting finger/s only penetration; the remaining two were lacerations seen in women who were uncertain about finger involvement and who, therefore may have been penetrated with finger/s. Only two injuries to the cervix were seen overall; an abrasion due to finger/s only penetration and a bruise due to penetration with penis and finger/s.

3.5.3. Penetration with an object

No women in this study were penetrated exclusively with an object, however five women gave a penetration history that included penetration with an object. Four of these 5 women were penetrated consensually and none of these sustained any injury; the nature of the object was not recorded in the consensual group. One woman was penetrated non-consensually with an object; she described it as a 'toilet roll holder' and was found to have three bruises on the labia minora and hymen.

3.5.4. Timing of examination

Lacerations and bruises were more likely to be seen at examination within 24 h of penetration. Abrasions were not seen in any woman examined more than 24 h after penetration and bruises were not seen in any woman examined more than 48 h after penetration. Thus, lacerations were the only type of injury seen in women examined between 48 and 72 h post-penetration. Table 14 summarises the different injury types seen in each consent group at different penetration to examination times (PET).

Most bruises seen in this study were red in colour (85%, 11/13) and all red bruises were seen in women examined within 24 h of penetration; nine of these eleven red bruises were seen in women examined within 12 h of penetration.

Most fossa navicularis injuries (85%, 17/20) were seen in women examined within 12 h of penetration. Injuries to the labia, hymen, perineum, clitoris and vaginal wall were only seen in women

Table 10
Consent group comparison of injury pattern.

	Non-consensual group ($n = 41$)		Consensual group ($n = 81$)		OR (95% CI)	p-Value
	n	%	n	%		
More than one genital injury	15	*36.6*	2	*2.5*	22.79 (4.88–106.36)	<0.005*
More than one injury at a single site	12	*29.3*	2	*2.5*	16.34 (3.45–77.49)	<0.005*
More than one site of injury	9	*22*	0	*0*	48.56 (2.74–859.42)	0.01*
More than one type of injury	7	*17.1*	0	*0*	36.04 (2.00–649.21)	0.02*
More than one laceration	9	*22*	2	*2.5*	11.11 (2.27–54.28)	<0.005*

*Statistical significance $p < 0.05$.

examined within 24 h of penetration. The only genital sites at which injury was seen between 48 and 72 h post-penetration were the posterior fourchette and peri-urethral area.

The largest injuries seen in this study were detected within 12 h of penetration; all injuries with a surface area of greater than 1 cm^2 and five of the six injuries with at least one dimension greater than 1 cm were seen in women examined within 12 h of penetration.

Examination of a woman within 24 h of penetration was significantly more likely to detect more than one injury [OR 10.0, CI (2.18, 45.96), $p < 0.005$]. All women who were found to have more than one type of injury or more than one genital site injured were examined within 24 h of penetration.

3.5.5. Other factors

Use of lubricant during any penetrative episode was significantly less likely to result in a laceration than a bruise or abrasion [OR 0.08, CI (0.01, 0.70), $p = 0.02$]. Lacerations were statistically more likely than abrasions or bruises, to be seen in women who had never delivered vaginally before than those who had [OR 3.55, CI (1.12, 11.31), $p = 0.03$]. Lacerations to the vaginal wall, perineum, hymen and inner labia majora were only seen in women without a history of previous vaginal delivery, whereas lacerations to the fossa navicularis, posterior fourchette and labia minora were seen whether or not a woman had delivered a baby vaginally. While the fossa navicularis was the most common site of injury overall, in women with a history of previous episiotomy, injuries were rarely seen at this site; only one of the 10 injuries seen in women who had had a previous episiotomy occurred at the fossa navicularis.

4. Discussion

4.1. Genital injury prevalence and consent

The key finding in this study was a significant difference in genital injury prevalence between women who were vaginally penetrated non-consensually and consensually; 53.7% of the non-consensual group *vs* 9.9% of the consensual group had any genital injury. The only other study comparing genital injury in consent groups using macroscopic examination, found 22.8% of non-consensual cases and 5.9% of consensual cases to have any genital injury.[23] All examinations in this UK study by McLean, with a much larger non-consensual group ($n = 500$), were conducted within 48 h of penile-vaginal penetration. However, non-consensual data was collected retrospectively by reviewing sexual assault service records whilst the consensual group ($n = 68$) was recruited prospectively; consensual group women had sex with prior knowledge of the study. All participants in McLean's study were 18 years or over, but 8% of non-consensual cases and 28% of consensual cases were over the age of 45 years; his sample included postmenopausal subjects while the study reported here did not. It is not clear whether illuminated transparent specula were used for examination in McLean's study; if not, the ability to detect vaginal and cervical injury may have been reduced. Neither was it clear whether participants were asked if any non-penile penetration occurred during the index vaginal penetrative episode. From the results of our study, it appears that penetration with finger/s frequently occurs together with penile penetration in both consensual and non-consensual settings and that finger involvement increases the likelihood of injury. Consideration of penetration scenario in detail, together with the possibility of other episodes of penetrative sex or recent non-sexual vaginal penetration such as tampon insertion or speculum examination in the 48 h prior to examination, is crucial for interpretation of findings. When women in our study who were examined within 48 h of penetration were considered separately to allow direct comparison with McLean's study, 41 were penetrated consensually and 58 non-consensually; differences in injury prevalence remained similar to that for the whole sample, with 53.7% of non-consensual group *vs* 10.3% consensual group found to have injury.

Two early staining/macroscopic examination studies that sought to compare genital injury in consent groups[26,27] provided separate data for macroscopically detected injury prior to staining. These studies found no injury in their consensual groups and injury in one woman in each non-consensual group (4%, 1/25 and 1/24 respectively). Another study comparing macroscopically detected injury with colposcopically detected injury in non-consensual cases cited a 6% injury prevalence with macroscopic examination.[32] Other macroscopic examination studies have cited non-consensual genital injury prevalence rates of between 9%[16] and 27%,[18,20] however the methodology used in these studies was not ideal for comparison with the study reported here.

A recent consensual sex genital injury study by Astrup[51] which recruited volunteers from a university student population and compared genital injury detected by macroscopic, staining and colposcopic examination, cited a macroscopically detected injury prevalence of 34%. This is significantly higher than that found in the study reported here and in McLean's study, both of which recruited

Table 11
Comparison of features of lacerations seen in each consent group.

	Non-consensual group	Consensual group
	43 lacerations in 13 women	10 lacerations in 8 women
Length	Up to 2.5 cm in length	Up to 1.5 cm in length
Shape	41 straight, 2 irregular	All straight
Most common site	Fossa navicularis	Posterior fourchette
Pattern	Up to 8 in an individual If > 1, more likely to occur at different sites than at a single site	Up to 2 in an individual If > 1, only occurred at a single site
	Sites of >1 laceration: Labia minora Fossa navicularis Peri-urethral area Posterior fourchette Vaginal wall	*Site of >1 laceration*: Posterior fourchette

Table 12
Injury types in different penetration scenarios by consent group (all injuries, $n = 84$).

Penetration scenario	Bruises ($n = 13$)		Abrasions ($n = 18$)		Lacerations ($n = 53$)		Total no of injuries due to this penetration scenario
	n	*%*	*n*	*%*	*n*	*%*	
Injuries in non-consensual cases ($n = 74$)							
Penis only	4	*14.3*	2	*7.1*	22	*78.6*[a]	**28**
Finger/s only	4	*26.7*	9	*60*[a]	2	*13.3*	**15**
Penis and fingers	2	*11.1*	4	*22.2*	12	*66.7*[a]	**18**
Penis, finger/s and object	3	*100*[a]	0	*0*	0	*0*	**3**
Unknown	0	*0*	3	*30*	7	*70*[a]	**10**
Injuries in consensual cases ($n = 10$)							
Penis only	0	*0*	0	*0*	6	*100*[a]	**6**
Penis and finger/s	0	*0*	0	*0*	4	*100*[a]	**4**

[a] Most frequent type of injury in a particular penetration scenario.

consensual group participants from general practice populations. It is possible the difference in outcome reflects the different recruiting populations, but further consideration of possible explanations for this difference is warranted.

4.2. Typology of genital injury and consent

The unexpected finding in this study that bruises and abrasions resulted only from non-consensual penetration may well be an artefact of the small sample size. However, the possibility that it relates to the clear distinction made by examining doctors between abrasions and lacerations cannot be discounted. The multiple tissue folds, elasticity and three dimensional nature of the female genitalia contribute to the significant challenges associated with examination of this part of the body.

As outlined earlier, the consent group comparison study most similar in methodological design to this study, is that of McLean.[23] Although the consensual group in this study ($n = 81$) was larger than McLean's ($n = 68$), injury prevalence was too low in either study for reliable conclusions about any relationship that might exist between consent and injury typology (9.9% *vs* 5.9% respectively). However, the lack of existing information about macroscopically detected injury typology necessitates careful consideration of typology findings.

Lacerations and abrasions were identified equally frequently in McLean's non-consensual group with 10% (52/500) found to have at least one laceration and 10% (48/500) at least one abrasion; only 7% (34/500) were found to have any bruises. This contrasts with the findings of the study reported here which identified 32% (13/41) of non-consensual cases with at least one laceration, 20% (8/41) with at least one abrasion and 24% with at least one bruise. McLean does not provide total individual injury numbers in his paper, but results of this study show lacerations to be the most common injury type overall in the non-consensual group (43 detected in 13 women), abrasions the next most frequent injury type (18 detected in 8 women) and bruises the least frequent (13 detected in 10 women). McLean's non-consensual data was retrieved retrospectively from sexual assault service records which is unlikely to have allowed an assessment of consistency in examiner injury identification or use of terminology.

Although the numbers of consensual group women with injury were small in both studies (8 in this study and 5 in McLean's study), typology findings were markedly different. All three injury types were seen in McLean's consensual group, with the most common injury type being a bruise, in contrast with this study's finding that only lacerations were seen in the consensual group.

McLean found the posterior fourchette to be the most commonly injured site in both consensual and non-consensual groups. This study identified the posterior fourchette as equally most common injury site with the fossa navicularis in the consensual group, while the labia minora and fossa navicularis were equally most frequently injured sites in the non-consensual group. McLean's study did not, however, identify the fossa navicularis as a distinct site and since it lies in very close proximity to the posterior fourchette, it is possible that his posterior fourchette injuries represent injuries to both sites. If this was the case, the results of the study reported here are in agreement with his findings in relation to most common site of injury.

Although injuries were colposcopically detected after staining, the typology findings of Anderson's 2006 consent group comparison study[44] were comparable to some extent with this study. Although all types of injuries were seen in each of her consent groups, 'tears', presumed to be lacerations, were the most common type of injury in both. Her findings with respect to total number of injuries seen in an individual were also similar; all except one of 14 injured consensual cases sustained a single injury only, while the majority of non-consensual injured cases (60%, 11/18) were found to have more than one injury. She identified posterior fourchette 'tears' as the most common finding in both her consent groups, and that consensual group injuries were never seen on the labia minora.

Table 13
Details of finger/s only penetration cases (all non-consensual, $n = 8$).

Case	Age (yrs)	Penetration to examination time or PET (h)	Any lubricant used?	Total no injuries	Type of injuries	Sites of injury
1	20	<12	No	None		
2	24	24–47	No	None		
3	22	12–23	No	1	Bruise	Hymen
4	41	12–23	No	1	Bruise	Fossa navicularis
5	42	<12	No	1	Laceration	Fossa navicularis
6	39	<12	No	3	Abrasions	Inner labia majora
7	24	<12	No	3	Laceration	Labia minora
					Abrasion	Posterior fourchette
					Bruise	Cervix
8	21	<12	No	6	Bruises	Inner labia majora
					Abrasions	Labia minora

Table 14
Injury types at different penetration to examination times by consent group (all injuries, $n = 84$).

Penetration to examination time (PET)	Bruises ($n = 13$)		Abrasions ($n = 18$)		Lacerations ($n = 53$)		Total no of injuries detected at this PET
	n	*%*	*n*	*%*	*n*	*%*	
Injuries in non-consensual cases ($n = 74$)							
<12 h	10	*15.4*	17	*26.2*	38	*58.5*[a]	**65**
12–23 h	2	*25*	1	*12.5*	5	*62.5*[a]	**8**
24–47 h	1	*100*[a]	0	*0*	0	*0*	**1**
48–72 h	0	*0*	0	*0*	0	*0*	**0**
Injuries in consensual cases ($n = 10$)							
<12 h	0	*0*	0	*0*	2	*100*[a]	**2**
12–23 h	0	*0*	0	*0*	0	*0*	**0**
24–47 h	0	*0*	0	*0*	5	*100*[a]	**5**
48–72 h	0	*0*	0	*0*	3	*100*[a]	**3**

[a] Most frequent type of injury in PET category.

Although the fossa navicularis was included as a distinct genital site in her study, no injuries were documented at this site in either group, in contrast to the findings of this study which found the fossa navicularis to be a more common site of injury than the posterior fourchette in the non-consensual group, and equally most frequently injured site with the posterior fourchette in the consensual group.

More recently, Astrup's consensual group study[51] identified lacerations as the most common macroscopically detected injury and the posterior fourchette as the most commonly injured site by any examination method. Only 3/98 of her cases were found to have more than one injury when examined macroscopically; comparable to 2/81 cases with more than one injury in this study.

4.3. Penetration scenario

The results of this study showed that, after adjusting for consent, penetration that involved finger/s was significantly more likely to result in genital injury than penetrative episodes that didn't. Penetration with both penis and finger/s or object has been previously identified as having a higher genital injury rate than penetration with penis only, in a non-consensual group study using colposcopic examination after staining.[35]

Penetration with finger/s only, though only occurring in a non-consensual setting in this study, was more likely to result in injury than any other penetration scenario. A study by Rossman is the only other to date looking specifically at injuries arising from penetration exclusively with fingers[80]; all her cases were non-consensually penetrated and examined colposcopically after staining. She identified a genital injury prevalence of 81% (43/53) similar to that of this study (75%, 6/8). However, in Rossman's study, participant age range was 13–78 years, 30% had not had sex before and redness was documented as an injury; all features likely to increase injury detection rate. She also found 'redness' to be the most common finding, followed by lacerations, abrasions then bruises; lacerations were most frequently seen on the posterior fourchette, abrasions on the labia minora and bruises on the cervix and hymen. In contrast, the study reported here which excluded redness, found that finger/s only penetration injuries were most commonly abrasions (60%, 9/15), and bruises (27%, 4/15) and that lacerations were the least likely injury type (13%, 2/15). Abrasions due to finger/s only penetration were found on the inner labia majora and cervix in this study which appeared to be unusual sites for sex-related genital injury across the study population. Injury to the inner labia majora in this study was significantly associated with finger/s only penetration and only two injuries to the cervix were seen in this study, both of which involved finger/s penetration.

Useful comment with respect to object penetration was not possible from the results of this study since only five cases involved object penetration, all in combination with penis and/or finger/s and only one occurred in a non-consensual setting. The only other study to consider genital injury due to foreign body penetration[81] reported vaginal and anal macroscopic examination findings in 19 women, all of whom were penetrated non-consensually, and found an injury detection rate of 75%. Only four were penetrated exclusively with an object and the inclusion of redness, swelling and tenderness as injury findings, is likely to have inflated injury prevalence rates.

In this study, though not statistically significant, the use of a condom and/or lubricant appeared to protect against genital injury to some extent. This result is difficult to interpret since more consensual cases than non-consensual cases involved the use of a condom or lubricant, but concurs with two non-forensic studies looking at the effect of recent consensual sexual intercourse on vulvo-vaginal epithelium with and without condom use.[3,4] Neither of these two studies, which used both macroscopic and colposcopic examination, identified any genital injury after consensual sex when a condom was used. It is worth noting however, that in these studies, sex-related genital redness was seen regardless of whether a condom was used or not.

4.4. Genital 'infection'

The considerable challenges involved with identifying the presence of genital infection at the time of penetration are responsible for a paucity of information about genital injury and pre-existing infection. The methodology used in this study, which included asking participants about genital symptoms and their timing of onset in relation to index penetration, together with the recording of any clinical and/or laboratory evidence of infection at examination, may provide a useful means of exploring this issue in future studies. In this study, the term genital 'infection' was used broadly to refer to any alteration in genital microbial flora. It was considered that pre-existing genital 'infection' at penetration was a reasonable presumption in four women in the consensual group who reported pre-penetration genital symptoms and had laboratory evidence of 'infection' at examination, two of whom had at least one genital injury. After adjusting for consent, genital 'infection' as determined by these variables was significantly associated with the presence of injury [OR 11.83, CI (1.41, 99.55)]. The role of pre-existing infection in sex-related genital injury causation warrants further investigation.

4.5. Timing of examination

This study found that the macroscopic detection of genital injury was more likely if a woman was examined within 24 h of penetration than if examined between 24 and 72 h after penetration [OR 4.88, CI (1.90, 12.54), $p < 0.005$]. This is supported by the

findings of another macroscopic examination study of non-consensual cases[11] and also a number of staining and colposcopic examination studies.[37,45,82–84]

In this study, lacerations were the only type of injury seen at examination between 48 and 72 h after penetration; however only consensual cases were examined in this time category. Abrasions were not detected in any woman examined after 24 h and bruises were not seen after 48 h. All red bruises were seen in women examined within 24 h of penetration and most (81%) within 12 h. This appears to contradict the results of a study of non-consensual cases using an unspecified examination method, that found that bruises were more commonly seen at examination 48–72 h post-penetration, suggesting that the appearance of a genital bruise was more likely to be delayed.[85] It is worth considering that red genital bruises may represent localised areas of increased blood flow due to vasodilation resulting from pressure, rather than 'true' bruising due to leakage of blood from damaged vessels. Localised red genital lesions have also been described as part of a 'focal vulvitis' syndrome[86–89] although the nature and prevalence of this condition remains unclear and continues to be the subject of some debate.[4] The possibility that focal red areas on the external genitalia represent inflammatory rather than traumatic lesions cannot be ignored and may ultimately render the forensic interpretation of 'red genital bruises' just as problematic as 'generalised genital redness'.

4.6. Hormonal contraception

Thirty per cent of women in the non-consensual group and 50% of those in the consensual group were taking some form of hormonal contraception. No significant relationship between hormonal contraception and the presence of injury was identified in this study which contrasts with a colposcopic sexual assault study that found genital injury to be more likely in those who were not taking hormonal contraception.[29]

4.7. Obstetric history

In this study, a detailed obstetric history was recorded for each participant with the purpose of identifying women who might have scarring or distorted genital anatomy following vaginal birth trauma, to determine whether this influenced the likelihood of sex-related injury. Although not statistically significant, genital injury was seen less frequently in women who had had at least one previous vaginal delivery. In this study, a woman who had never previously delivered a baby vaginally was, however, significantly more likely to sustain at least one laceration. Some sexual assault studies have explored the association of injury with 'parity' or 'nulliparity' but without details of whether the birth was vaginal or not, or whether participants had experienced birth-related injury or episiotomy. One large sexual assault study using all three methods of genital examination identified genital injury as being less likely the more pregnancies a woman had had.[46] However, two other sexual assault studies, one using macroscopic examination[20] and the other colposcopy[29] found no relationship between injury and previous pregnancy. Studies that consider the type and sites of genital injury seen in women who have had previous birth-related injury or procedures, could not be found. In the study reported here, lacerations to the vaginal wall, perineum, hymen and inner labia majora were only seen in women without a history of previous vaginal birth. Fossa navicularis injuries were less frequent in women who had had a previous episiotomy than those who hadn't, despite this being the most common genital site overall, for an injury to be seen.

The tentative conclusion that obstetric history may affect the likelihood of sex-related injury is not unreasonable, given the possibility that genital tissue may be irreversibly altered in some way after the vaginal birth process. However, whilst scarring generally causes contraction or shrinking of tissues, which in the genital area may reduce the size of an orifice or opening thereby making it more prone to injury, scarring may also create tissue that is more resilient to blunt force and therefore less likely to sustain injury. The results of this study, though not conclusive, suggest that genital sites such as the fossa navicularis where scarring due to birth-related tears or episiotomy is likely, might in fact be less prone to injury.

4.8. Strengths, limitations and implications for future research

The major limitation of this study was its small sample size. While statistical power was adequate to detect a significant difference in injury prevalence between consent groups, the small number of consensual cases found to have genital injury prevented definitive conclusion about relationships between consent and the typology and pattern of sex-related genital injury. The small sample size was, however, the result of a narrowly defined prospective design which was also one of the study's major strengths.

Prospective recruitment to both non-consensual and consensual groups was a key feature of this study's design. Recruitment to the consensual group at the time of presentation for examination removed any potential bias related to prior knowledge of study participation upon consensual sexual behaviour. Recruitment of consensual group participants from a variety of primary health care settings ensured they were representative of a broad range of socio-economic groups. The suggestion that women with genital injury arising from recent sex may be less likely to present for genital examination, is frequently raised in discussions around studies of this nature. In this study, 39% (16/41) of non-consensual group women and 16% (13/81) of consensual group women reported genital symptoms such as genital pain, bleeding or dysuria at the time of examination. Genital symptoms did not deter these women from seeking examination or indeed, in the case of four women who reported that their genital symptoms were present prior to the index penetrative episode, from having consensual sex.

Genital injury consent group comparison studies are only of value if they involve standardised data collection and examination protocols for all participants, regardless of consent group membership. Examination of both groups by similarly experienced examiners with the ability to distinguish injury from infective or inflammatory genital conditions which mimic injury and to forensically identify injuries using consistent, accurate terminology is critical. Experience in female genital examination also promotes better visualisation of the genitalia and detection of injuries. Whilst considerable expertise in both forensic and gynaecological genital examination was a pre-requisite for examiners in this study, the absence of any test of 'inter-observer reliability' to verify consistency between examiners was problematic. The challenges involved in achieving consistency, especially with distinguishing between genital lacerations and abrasions, present a considerable problem for genital injury research. Without photographic documentation of findings, reliably consistent identification of injury and genital site cannot be demonstrated. Inter-observer reliability can only be measured if addressed specifically in the study design.[36,90,91] Furthermore, the issue of 'intra-observer variability' where an examiner may be inconsistent within their own practice, cannot be ignored.[92] This is a source of some debate currently in Australia, where macroscopic examination of adult sexual assault complainants without photographic documentation is standard practice. It could be argued that, based on the findings of this study which suggest a possible relationship between injury typology and consent, non-magnified photo-documentation of genital findings

should be performed routinely as part of any forensic sexual assault examination. This is the only means of achieving reliable and robust genital injury data, and would provide security for the courts when interpreting the significance of this type of evidence, as well as a valuable learning tool for forensic examiners[93].

Whilst the use of 'blinded' examiners who are unaware of whether penetration was consensual or non-consensual at examination would be ideal, it is difficult to achieve in research involving examinations of a sensitive nature. The use of different doctors to examine each consent group, as was the case in this study, may have reduced potential for bias to some degree, whilst familiarity and adherence to the core forensic principle of impartiality should contribute to an objective approach.

Recruitment to any non-consensual group is associated with difficulties confirming the veracity of an allegation, particularly when intoxication with drugs or alcohol is involved. This study sought to address these concerns in part by recruiting only police reported cases of sexual assault to the non-consensual group and excluding any cases involving intoxication where there was no clear memory of vaginal penetration, or a history strongly suggestive of vaginal penetration. Regrettably, information about intoxication at time of penetration was only recorded for the non-consensual group in this study. Intoxication of either party involved in sexual behaviour may play an influential role in injury causation, whether in a consensual or non-consensual setting, and for this reason, such information should ideally be sought from all participants. Genital injury may occur if parties are less inhibited and more readily engage in activities that might lead to injury, or if a woman cannot readily communicate pain or discomfort during penetration to a sexual partner. On the other hand, injury may be less likely to occur if a woman is incapacitated by intoxication and offers little or no resistance to penetration.[94–96]

Information about sexual position is likely to be of relevance to injury causation, and was not sought from participants in this study. One study which did seek this information from participants,[23] did not identify any significant association of sexual position with genital injury. However, any consideration of the mechanism of sex-related injury causation requires further exploration of this aspect. The value of pursuing a means of quantifying 'degree of roughness' associated with penetration, as some researchers have attempted,[51,97] remains unclear. Whilst of potential relevance, estimates of the duration of time over which penetration occurred, may be similarly unreliable.

The use of saliva as a lubricant for vaginal penetration was spontaneously reported in this study by a number of women in both consent groups. However, since not all women were questioned about this, it was not included in data analysis. Because of its potential to facilitate penetration and reduce the likelihood of injury, this would be a valid inclusion in future similar research.

A 72 h penetration to examination time (PET) was chosen for this study because of jurisdictional guidelines with respect to forensic sexual assault examinations. Since the evidence for different 'cut-off' times for forensic examination is less than robust and consensus has not yet been achieved,[98–100] the need for matched consent group studies using a range of penetration to examination times is apparent and could be addressed with larger study populations. With the prospect that injury typology may prove important, further investigation of the timing of genital injury appearance is critical. Studies involving multiple examinations of the same individual at defined times after consensual and non-consensual vaginal penetration are the only way to achieve an understanding of how soon different injury types become visible, the sites at which they are seen and how long they persist for. Despite the considerable challenges involved, some researchers have already successfully progressed this issue.[7,51]

5. Conclusion

This study has identified useful information in relation to macroscopically detected genital injury, vaginal penetration and consent. Genital injury was significantly more likely to occur with non-consensual than consensual penetration, with penetration involving finger/s and when pre-existing genital 'infection' was likely. When controlling for finger/s penetration and pre-existing infection, injury was approximately twenty times more likely to occur if penetration was non-consensual than if it was consensual.

Results also revealed the possibility that genital injury typology may differ between consent groups and suggest that macroscopic genital examination may be uniquely placed to identify such forensically relevant differences if they exist, because of the potential for colposcopy and genital staining techniques to detect minor genital epithelial changes of unknown significance.

The results of this study highlight the importance of a standardised means of detecting genital injury based on consistent injury definitions, examination protocols, and examiner experience. The need for larger prospective consent group comparison studies and the development of genital injury databases to improve understanding of sex-related injury causation is evident, with acknowledgement that the legal implications of such research demands careful study design and robust methodology.

Since the rationale for this study was to assist with the forensic interpretation of genital injury in sexual assault complainants, the issues addressed were necessarily focused on questions posed by the legal system in sexual offence investigations. Whilst it is not the responsibility of the medical witness to answer the question of 'consent' for the courts, the value of information which improves understanding of sex-related genital injury and its relevance to sexual offences cannot be underestimated.

Ethical approval

This research was conducted as the basis for a Doctor of Philosophy thesis at the University of Western Australia (UWA) and as such, was approved by the *UWA Human Research Ethics Committee (HREC),* which is bound by the *National Health and Medical Research Council (NHMRC) Ethics Guidelines.* In addition, approval for the study was granted by each hospital and primary health care service at which examinations were conducted.

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Conflict of interest

None declared.

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